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IMPORTANT DISEASES OF PEPPER IN GEORGIA

By

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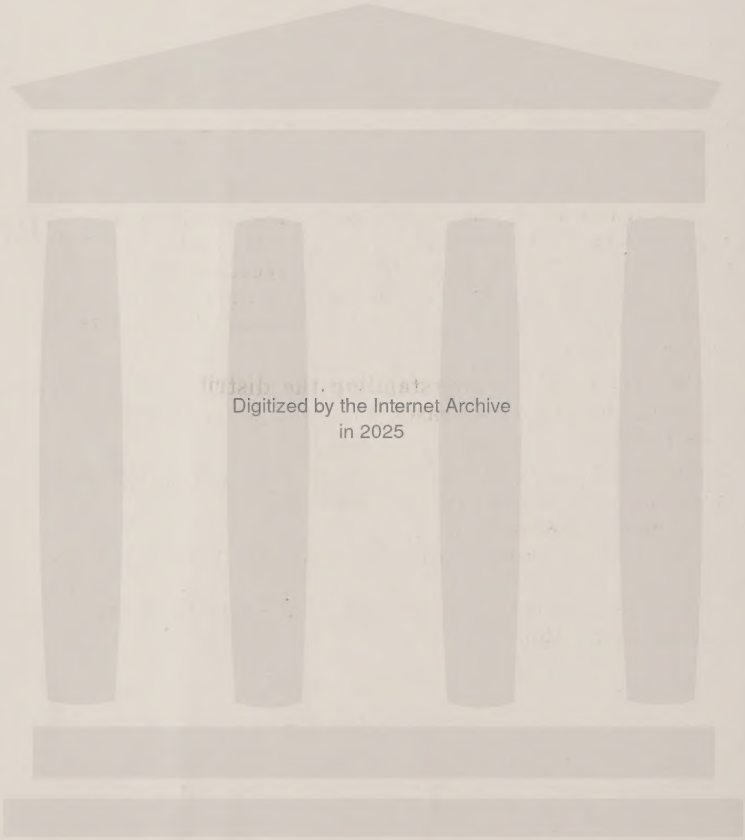
Bulletins of this Station sent free to residents of Georgia

H. P. STUCKEY, *Director*

EXPERIMENT, GA.



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IMPORTANT DISEASES OF PEPPER IN GEORGIA

B. B. Higgins

INTRODUCTION

The purpose of this bulletin is to describe the more important diseases of pepper so that they may be recognized by the grower and to give the latest development in methods of control.

Since the publication of our original work on the subject* some of the diseases described therein have proved of little importance under our conditions, and two serious diseases, "Ripe Rot" and "Downy Mildew" or "Blue Mould," have appeared in Georgia. Also considerable information has accumulated, suggesting improvements in cultural practices and other means of controlling these diseases.

The pimiento is an important canning crop in Georgia and the diseases discussed herein have been studied mostly on the Perfection pimiento; however, the results and recommended control measures apply to other types of pepper, with perhaps one notable exception: "Ripe Rot" causes little damage to peppers that are marketed green.

For convenience in understanding the distribution and means of controlling the pepper diseases discussed here, they may be classified as follows:

Soil-borne diseases: Damping-off, Southern Blight, Root Knot
Wind-borne diseases: Downy Mildew.
Insect-borne diseases: Mosaic.
Physiological diseases: Blossom-end Rot, Internal Mould, Sunscald.
Seed-borne diseases: Cercospora Leaf-spot, Bacterial spot, Anthracnose, Ripe Rot.

DAMPING-OFF

(Rhizoctonia solani)

Damping-off of pepper plants in the seed bed is quite general and often causes severe losses. It is caused by a fungus *(Rhizoctonia)* which grows on or near the surface of the soil and attacks the young plants causing the stems to rot off at the soil surface (Fig. 1). The diseased plants often drop over while the leaves are still green, giving the impression that the stem has been gnawed by insects.

The same fungus attacks a great variety of plants and is present

* Diseases of Pepper. Ga. Exp. Sta. Bul. 141:48-75. 1923.

to some extent in most fertile soils. In a seed bed it usually appears first in one or a few isolated spots, but under moist conditions often maintained in seed beds it spreads rapidly, killing every plant with which it comes in contact.

Under ordinary conditions damping-off can be effectively controlled by keeping the surface of the seed bed stirred and dry, since the fungus cannot spread over loose dry soil.

Pepper seed should be planted in rows four to six inches apart and the soil between the rows should be stirred as soon as possible after each rain. When it becomes necessary to water the bed it should be wet thoroughly and the soil between the rows should then be stirred as soon as dry enough. Ordinarily one thorough watering each week should keep the plants growing rapidly.

During a rainy period, when it is impossible to keep the surface soil loose and dry, a line of hydrated lime (old air-slaked lime is better) between the rows will aid in preventing spread of the damping-off fungus. Another effective, though more expensive, means of control is to soak the soil of the diseased area with a solution of Semesan. Add one ounce of Semesan to three gallons of water and allow to stand, stirring occasionally, for 30 minutes or longer and then apply at least one quart of the solution to each square foot of soil, being careful to wet several inches outside the area of diseased plants.

FIG. 1. *Pepper plants girdled by a "Damping-off" fungus*

The grower must keep in mind the fact that plants attacked by the damping-off fungus cannot be cured. The control measures recommended are merely to prevent spread of the disease. Therefore, the seed bed should be watched carefully and some treatment applied as soon as the first sign of disease is noticed.

Mixing lime or sulphur with the seed bed soil has little or no value in controlling damping-off.

SOUTHERN BLIGHT OR SCLEROTIUM BLIGHT

(Sclerotium rolfsii)

This, one of the most serious pepper diseases in Georgia, is a soil-borne disease in the sense that the causal fungus lives over from year to year in the soil. It is most abundant and causes the heaviest losses in the lighter, sandier types of soil, but is present to some extent in the heaviest clay soils.

The fungus requires a comparatively high temperature for active growth and the disease does not appear in pepper fields of middle Georgia until about the first of June. During periods of warm rainy weather the fungus grows over the surface of the soil and attacks the plants near the soil line, causing the bark to decay at this point (Fig. 2). The leaves wilt and the plant soon dies. If the plant is pulled up the cottony mould-like growth of the fungus may usually be seen on the dead portion, accompanied by small, brown bodies about the size and shape of mustard seed. These are the sclerotia or resting bodies of the fungus which serve to reproduce it after periods of unfavorable conditions. For instance, the sclerotia will withstand drying over long periods and at temperatures several degrees below freezing without injury, while the vegetative growth of the fungus is quickly killed by either drying or freezing.

FIG. 2. *Base of blighted pepper plant showing strands of fungous growth near soil line*

During periods of dry weather the fungus penetrates deeper into the soil and usually attacks the roots of the pepper plants, but produces the same type of wilting and death.

Extensive studies have been carried on in an effort to devise some practical method of controlling the disease. We found that it could be controlled quite effectively by working sufficient

lime into the surface soil to make it distinctly alkaline. However, on our heavy clay soils this would require the application of two to four tons of hydrated lime per acre, and the value of the pimiento crop will not justify the expense of such heavy applications. We found also that the plants could be protected by applying solutions of mercury salts to the soil at the base of each plant, but here again the cost of such applications is prohibitive. Except under special conditions, the value of the pepper crop will not justify the cost of material and labor.

Clean cultivation and crop rotation are the only means of control that can be recommended for general use. Pepper should never be planted in a field two years in succession.

The same fungus *(Sclerotium rolfsii)* attacks a great number of other crop plants and weeds. It is particularly bad on the soybean, cowpea, velvet bean, sweet potato, tomato, cantaloupe, watermelon, and a number of vegetable crops; and any of these crops may greatly increase the amount of the fungus in a soil. Cotton, corn, small grains, and grasses are practically immune under our conditions. It seems desirable, therefore, to have pepper follow one of these crops. Since the fungus attacks more than 100 species of weeds, one can readily see the importance of clean cultivation for pepper and the crop which precedes it.

NEMATODE ROOT-KNOT

(Heterodera radicicola)

The pepper plant is quite susceptible to injury by the nematode, a microscopic worm which bores into the young roots causing swelling and distortion of the roots. Most pepper growers are familiar with the disease. In severe cases the plants are stunted and pale. They appear starved in spite of heavy fertilization. When such plants are dug or pulled carefully the roots are found to be distorted and knotted with swellings of various sizes.

Nematode injury is most serious on the lighter sandy type of soil. On the heavier clay soils the minute worms cannot migrate rapidly, and severe damage to pepper plants rarely occurs on such soil except when the plants become infected in the seed-bed. However, where pepper or other very susceptible crops are grown on a field year after year nematodes may become abundant and cause severe damage on the heaviest clay soils.

With proper care in selecting seed-bed soil and crop rotation comparatively little damage by nematode may be expected on the clay soils in the Piedmont section of Georgia.

When plants from other sections are bought the roots should be

examined carefully for root-knot and the entire shipment discarded, if any is found.

DOWNY MILDEW OR BLUE MOULD

(Peronospora sp.)

This fungus occurs on tobacco, tomato, and pepper, but is serious only in seed beds and on very young plants. It is occasionally found in fields, but there the damage is slight.

During a period of cool rainy weather in the spring of 1932 it caused serious damage to pepper beds throughout middle Georgia, but after a week of bright sunshine the disease practically disappeared and many of the diseased plants recovered.

Apparently the spores of the fungus may be blown long distances and remain viable, provided the air is cool and moist. The spores, falling on a leaf of a pepper seedling, germinate and infect the leaf. The fungous threads penetrate the leaf tissue and quickly spread throughout the leaf. The diseased portion turns pale and a new crop of spores is produced on the under surface, giving a pale bluish color and a downy appearance to the leaf surface. After a few days the leaf dies. On very young, tender plants the fungus often grows throughout the softer portions, young leaves and bud, of the plants causing death. In reporting the trouble many growers have remarked that the beds appeared to have been scalded with steam. On older hardened plants only the leaves are killed and the plants usually recover with the return of sunny weather.

The disease has been serious on pepper plants only one season and we have not had sufficient experience to allow definite evaluation of control methods. Our own results, and the results obtained by several growers, indicate that spraying with either lime sulphur (strength used for summer spray on peaches) or Bordeaux mixture (3-4-50) is of considerable value if applied before infection is general in the beds. The spray should be applied with a power sprayer, when possible, and with sufficient force to blow the plants over and coat both surfaces of the leaves.

MOSAIC

(virus)

Two types of mosaic have been noted on pepper in this region. One, producing a distinct mottling or calico effect on the leaves is not very common. The other causes more or less distortion of the leaves and does considerable damage at times. The diseased plants may usually be recognized by the more slender, somewhat wrinkled

leaves and paler green color. In severe cases the fruits become distorted and worthless, the flower buds drop without opening, and no new fruits are set. On the Perfection pimiento the disease

FIG. 3. *"Calico" type of mosaic on pepper leaves*

FIG. 4. *Pepper leaves affected with "Crinkle" type of mosaic*

symptoms disappear to some extent and an apparently normal crop of fruits is produced during the summer, but the symptoms reappear during cool rainy periods in the fall.

The exact cause of mosaic has never been determined. It is classed with the "virus" diseases; but whether this virus is an organism too small to be seen with the ordinary microscope or is merely an injurious chemical compound is not known. The virus of the pepper mosaic is transmitted from plant to plant by plant lice and possibly by other insects. It may be spread from plant to plant on the hands while picking the fruit and during other cultural operations, but migrating plant lice appear to be the principal carriers of infection.

At one time we suspected that the infective principle was carried over from year to year in pepper seeds, but apparently this is not the case. On several occasions seed have been saved from badly diseased, distorted fruits and planted under controlled conditions, but diseased plants have not been obtained. It is readily transferred from tomato plants to pepper and from pepper to tomato. Other workers have demonstrated that the disease passes through the winter on certain species of perennial weeds. Although we have never succeeded in transferring the disease to pepper from any of our native weeds, it seems probable that some perennial weed may be the source of infection.

As a control measure clean cultivation is recommended. The seed beds and fields should be kept free from weeds at all times. If plant lice appear the plants should be sprayed or dusted with some contact insecticide such as nicotine.

BLOSSOM-END ROT

(physiological)

This is perhaps the most common spot on pepper fruits. It is nearly always present in the field and is especially prevalent early in the season. Sometimes as much as 90 per cent of the first fruits set on the plants show more or less injury.

The spots appear at or near the blossom end, most commonly when the fruits are about half grown. The first noticeable symptom is a water-soaked condition which may appear in one or more small areas (Pl. I, Figs. 3-8), or in severe cases the whole lower half of the young fruit may be involved (Pl. I, Fig. 4). After a few hours the tissues of this water-soaked area collapse and dry out, leaving the spot white and papery, and they may remain in this condition until the fruit is mature. However, the spots commonly become infected with mould fungi which discolor and enlarge them, making the fruits worthless.

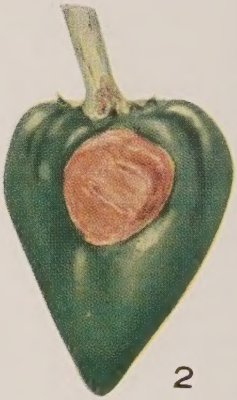

PLATE 1, Figs. 1 and 2. Types of sun-burned spots on green fruits of the Perfection pimiento.

Figs. 3 and 4. Early stages of blossom-end spot on fruits of Perfection pimiento.

Fig. 5. Later stage of same in which the spot has dried without becoming infected.

Figs. 6, 7 and 8 Older spots which have become infected with various fungi.

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PLATE II. Figs. 9 and 10. Perfection pimiento fruits showing Ripe Rot *(Vermicularia capsici)* spots in various stages of development.

Figs. 11 and 12. Anthracnose *(Gloeosporium piperatum)* spots on green and ripening fruits.

Fig. 13. Bacterial *(Bacterium vesicatorium)* spots on ripe fruit.

Fig. 14. Internal rot in off-type Perfection pimiento fruit. A mould fungus has entered through the dead pistil.

The spotting is caused by irregular water relations of the plant. The plants are set into the fields here during the latter part of April and early May, and the first fruits appear early in July. When rains are frequent through June and the first half of July the plants grow off rapidly forming a heavy growth of foliage and a shallow root system. Then during dry periods in July the roots are mostly in the dry surface soil, the leaves lose water faster than the roots can supply it, and the leaves wilt. The wilting leaves withdraw water from the fruits, and the soft tissues around the vein endings near the blossom end collapse and die. At night the plants become filled with water again, and water fills the spaces between the dead cells at the blossom end, giving the water-soaked appearance to the spots.

After the plants become thoroughly established with a deeper root system they are not so seriously disturbed by dry hot weather and the trouble largely disappears. Serious loss from blossom-end rot is unusual after the first or second picking.

Since irrigation of pepper fields is not feasible and the distribution of rainfall cannot be controlled, the most logical means of reducing loss from blossom-end rot is to get the root system of the plants as deep as possible early in the season. This involves care in the whole cultural system of the crop. The soil should be plowed early and as deep as possible. The fertilizer should be placed deep, well below the point where the roots of the young plants will be. The plants should not be set in the field until large enough to allow the roots to be placed at least four inches below the surface. And, perhaps most important of all, is the frequent and thorough cultivation after the plants are set in the field. During the first six weeks the soil should be cultivated fairly deep, at least two inches, and as soon as possible after every rain to prevent root formation near the surface. After the plants begin to set fruit, cultivation should be frequent but shallow.

INTERNAL MOULD

Internal mould is usually, as the name implies, confined to the interior of the fruit. Fruits graded as perfect at the cannery receiving door may be so badly moulded inside (Pl. II, Fig. 14) as to make them worthless. The loss is usually heaviest during September when the pimientos ripen during periods of dry weather.

Internal mould is rarely found in fruits of the true ox-heart type of pimiento, but it is common in the fruits with a flattened, thin-fleshed tip. Under drought conditions the old pistil on the thin-fleshed tip dries and dies; and moulds entering through the dead tissue spread over the interior of the fruit. Several different species

of fungi and bacteria have been found in such fruits. Most of them cause little decay of the pepper tissues, but they become so firmly attached to the interior wall of the pod that they cannot be washed out. Consequently the fruit is worthless for canning.

Occasionally these mould fungi may enter the thick-fleshed typical Perfection pimiento fruits through the wart-like bacterial spots, but they rarely enter sound fruits of this type.

Lack of uniformity in pimientos at the canneries indicates that there has been some crossing of the Perfection with other varieties of pepper. At present there is pressing need for more careful selection of seed stocks.

SUN-SCALD

The Perfection pimiento usually has very heavy foliage and there is little loss from sun scald unless the plants drop their leaves from the effect of severe drought or of leaf-spotting diseases.

In fields badly defoliated by bacterial spot or Cercospora leaf-spot a very high percentage of both green and ripe fruits develop scalded areas (Pl. I, Fig. 1) on the side exposed to direct sunlight.

This loss of fruits emphasizes the importance of controlling these two serious leaf diseases.

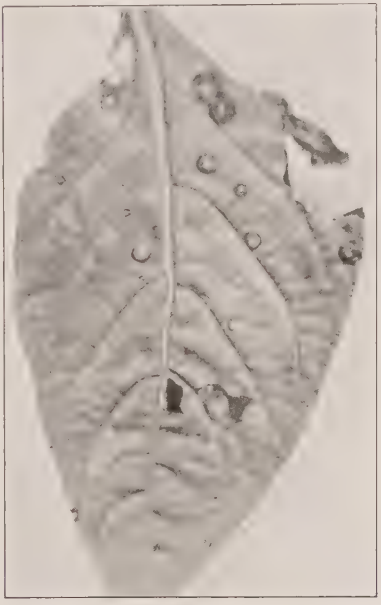

FIG. 5. *Cercospora spots on pepper leaf*

CERCOSPORA LEAF-SPOT

(Cercospora capsici Heald & Wolf)

This is easily distinguished from other leaf diseases by the large circular or oblong spots, one-fourth to one-half inch in diameter, dark brown, with usually a distinct white or grayish center (Fig. 5). When infection becomes severe the leaves turn yellow and drop off. It is commonly present and often does serious damage on all types of pepper, especially where seed treatment is not practiced. In sections where seed treatment has been practiced for the past few years this disease has practically disappeared.

The results from two years spraying tests indicate that the disease can be controlled by spraying with Bordeaux mixture, but the increased yield will not pay the cost of spraying in an average year. Seed treatment with chemical disinfectants gives such thorough control at a minimum of cost that no other control method seems desirable.

BACTERIAL SPOT

(Bacterium vesicatorium Doidge)

Bacterial spot affects both leaves and fruits. Small wart-like raised spots are produced on the fruits (Pl. II, Fig. 13). The intercellular spaces in the infected area become packed with the bacteria. The cells enlarge and divide, producing the wart-like swelling. In old spots the bacteria penetrate through the flesh into the interior cavity of the fruit, but no decay is produced. However, fungi frequently enter through the spot causing the fruit to rot or in some cases producing the internal mould previously discussed.

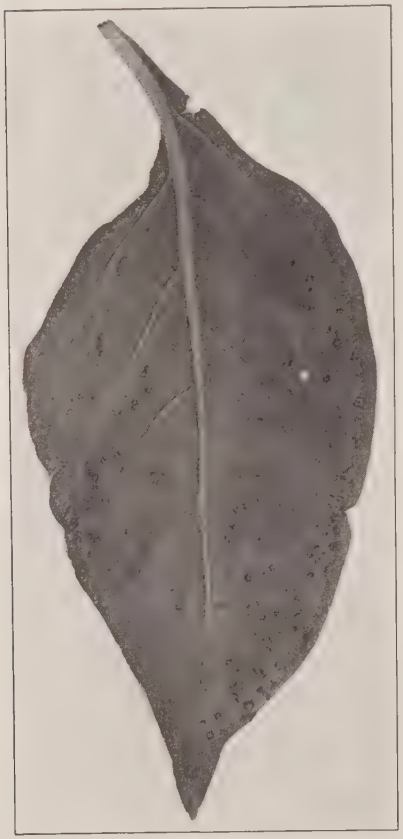

FIG. 6. *Bacterial spot on pepper leaf*

The broken cuticle over the warty area allows the flesh to dry out to some extent and the spot may burn through during the roasting process. Spots that do not burn through must be cut out, spoiling the fruits for No. 1 pack. Badly spotted fruits are worthless for canning.

The greatest damage occurs on the leaves. Here the spots are at first raised and wart-like but after a few days the tissues usually dry out and collapse, leaving a small dark-brown spot. Affected leaves soon turn yellow and drop off. During periods of rainy weather the disease spreads rapidly and defoliation often becomes so

severe that the plants are stunted and cease setting new fruits. This has been extremely prevalent throughout middle Georgia during the 1934 season.

When seed are removed from infected fruits or fruits from infected plants the hands of workers become covered with the bacteria which are then smeared over the seed and held there by the viscous seed coat. The bacteria will live for at least a year on the dried seed. When such contaminated seed are planted the bacteria enter the leaves or stems of the young plant. The disease spreads rapidly under seed bed conditions and by the time plants are set into the field every plant may be infected.

Apparently the bacteria live over in the old plants left in the field. While we have not been able to prove this by experimental methods, numerous observations indicate this to be true.

Another common source of infection is diseased tomato plants. The same species of bacteria causes spotting of tomato plants, leaves, and fruits; and the bacteria are commonly present on commercial tomato seed. It is common practice of pepper growers to plant a few tomato seed in the pepper plant bed. A single infected tomato plant is sufficient to spread the disease over the entire bed. In the spring of 1934 some tomato plants grown from untreated commercial seed were planted near some pepper fertilizer plats on the Experiment Station grounds. The tomatoes showed a few bacterial spots when set. By the middle of August every pepper plant showed heavy infection and severe defoliation, while pepper plants set in three other fields were free from this disease.

It is not good practice to plant tomato and pepper in the same seed bed unless the seed of both have been given a disinfectant treatment. Directions for disinfecting the surface of pepper seed are given on page 19.

Crop rotation is also important in control of this disease.

ANTHRACNOSE

(Gloeosporium piperatum E. & E.)

Anthracnose causes some damage nearly every year in a few fields, but where care is used in selecting seed and crop rotation is practiced this disease is never so general in distribution nor so destructive on pimientos as bacterial spot or ripe rot.

It produces circular, sunken spots (Pl. II, Figs. 11 and 12) on green or ripe pepper fruits of all varieties grown in this region. During damp, rainy weather salmon pink masses of spores may be seen on the surface of the spots, usually arranged in concentric circles. Rains wash and spatter these spores to other fruits and

start new infections. During a rainy season it may cause heavy losses, if present in a field.

The fungus grows through the flesh and then spreads throughout the seed cavity. It pentrates the seed coat and forms thick-walled cells which may live at least two years inside the dried seed coat. The spores from the surface of the pod become smeared over the seed in harvesting. When seed bearing either the internal or the surface contamination are planted, the fungus attacks the young seedlings before they emerge from the soil and lives on the leaves and stem of the plant all summer. The injury on the plant is not conspicuous but it serves as a source of infection for the fruits.

Surface disinfection of the seed may kill the spores of the fungus but no treatment tried will kill the mycelium within the seed coat.

Losses from this disease appear to be easily avoided by crop rotation, by carefully selecting only sound fruits for seed stock, and by careful handling of seed to avoid contamination during and after harvest.

RIPE ROT

(Vermicularia capsici Syd.)

This is the most serious and destructive disease with which the pimiento grower or the pimiento canner has to contend. It has been designated "Ripe Rot" because, although fruit infection may occur at any time between blossom-fall and ripening, no evidence of infection is visible until the fruit turns red. In India the same fungus causes a die-back of pepper plants. In Georgia it is frequently found on leaves and stems but it does little damage to the plants under our conditions, doubtless because of the less humid climate.

It was first reported in the United States from Dyas, Georgia, in 1929. The following year it was reported about Macon, Forsyth, and Barnesville, and in 1931 was found about Woodbury and in a few fields near Griffin. It is now generally distributed throughout the pimiento growing regions of Georgia and causes serious losses every year.

As the infected fruits begin to ripen small, yellowish spots appear (Pl. II, Figs. 9 and 10). If the weather is dry the spots may show no further development before the fruits are harvested. The grower usually harvests his pimientos the day before they are to be delivered at the cannery, then sorts and packs them into bags or into a truck for delivery at the cannery. The small yellowish spots are not conspicuous and are usually overlooked during the field sorting; but, under moist conditions developed in the bags or in piles of pimientos on the ground or in a truck body, many of them become large, sunken, soft spots before reaching the cannery. Often 50 to

75 per cent of a load must be sorted out and discarded at the cannery, but even this does not represent the total loss. Many of the small yellow spots escape this second inspection. When such spotted fruits are roasted the spots burn through making the fruits unfit for a high-grade pack.

As with Anthracnose, the fungus penetrates to the seed cavity and infects the seed internally so that seed treatment is ineffective in controlling the disease.

Some infected fruits seem to escape the most rigid inspection in selecting seed stock at the cannery. The only safe way of obtaining disease-free seed is to save them from fields that are known to be free from this disease as well as from Anthracnose.

We have found definitely that the fungus lives over at least one winter in the old decayed fruits left in the field. It is not safe, therefore, to plant pepper in a field where this disease has been present the previous year.

So far we have not been able to find the fungus which causes ripe rot on any other plant. Apparently the principal means of spreading the disease has been on infected seed. Once it has been introduced on a farm it may remain as long as pepper is grown unless care is used in destroying diseased material and in placing the pepper each year at some distance from where it was grown the previous year.

CONTROL OF SEED-BORNE DISEASES

There are five important factors in the control of the leaf-spot and fruit rot diseases of pepper, namely: seed selection, surface disinfection, sanitation, crop rotation, and spraying. In areas where peppers are grown commercially on a large scale none of the first four factors can safely be neglected, and the fifth is important.

SEED SELECTION. Since the organisms causing these diseases are carried over winter and disseminated widely on seed, the importance of clean, disease-free seed cannot be stressed too strongly. It appears almost impossible for the pimiento canneries to keep their seed stock free from disease under present conditions. Quantities of diseased pimientos are brought to the canneries daily and disease-producing organisms become generally distributed about the plant, on floors, on baskets, on the shelling machinery, on hands of the workers, and on the seed drying racks. Then too, with the most rigid inspection, some diseased pods are passed into the seed stock.

The Experiment Station has demonstrated the possibility of growing pepper free of these diseases during the past six years, while diseased peppers were growing throughout the neighborhood,

sometimes on the Station farm. With a small outlay for supervision the canneries may be able to furnish disease-free seed to the growers.

This can be accomplished by (1) selecting one or more farms where pepper has not been grown during recent years; (2) furnishing the farmers with seed known to be disease-free; (3) seeing that no other peppers or tomatoes are planted either in the seed bed or near the pimiento pepper fields; (4))spraying the plants in the seed beds; (5) saving and treating the seed by hand until sufficient quantity is available to supply their needs. After this the seed may be saved at the cannery, if properly supervised and if proper care is used to insure that no seed are saved from fields where either Anthracnose or ripe rot is present.

SEED TREATMENT. The surface disinfection of vegetable and crop seeds is such an effective means of reducing losses from diseases and so inexpensive that it should be adopted as a general farm practice. The aim in treating pepper seed is to destroy any disease producing organisms that may be on the surface without injuring the seed. This ideal is not easily attained. Pepper seed are quite sensitive to some of our most effective disinfectants, while some of the pepper parasites are not easily killed. Mercuric chloride solution is the most effective disinfectant that we have tried but it often injures the seed severely. The seed are much less sensitive at the time they are removed from the fruits than after drying, and the fungi and bacteria are more easily killed while the seed are still moist. For these two reasons we have urged for some years that all pepper seed be surface disinfected before drying, and some of the canneries follow the practice regularly.

Semesan, an organic salt of mercury, manufactured by DuPont de Nemours Company, approaches more nearly the ideal disinfectant for pepper seed than any other substance tried. It should be dissolved in water, one ounce Semesan to three gallons water. The seed as soon as shelled from the fruits and still moist should be soaked 60 to 90 minutes in the solution, drained and then spread thinly to dry. The seed should be stirred occasionally while soaking. Since the seed remove considerable quantities of the disinfectant from solution not more than three lots of seed should be treated in a batch of solution. Tests of this treatment over a number of years indicate that it is quite effective in destroying seed-borne fungi and bacteria and causes little or no injury to germination of the seed. It also protects the seed from destruction by mice and insects.

Copper sulphate solution has also given good results with fresh seed. The copper sulphate (bluestone) should be dissolved in water at the rate of one ounce to two quarts of water, the seed

soaked for five minutes, drained, dipped in lime water, and then spread out to dry.

To dissolve the copper sulphate, it should be tied in cheesecloth, or other porous cloth, and suspended just below the surface of the required amount of water. Otherwise, it is difficult to get it all dissolved.

Copper sulphate is also one of the best disinfectants for use on pepper seed that have been dried. Soak the seed in water six to 12 hours, drain off the water, soak for five minutes in the copper sulphate solution (one ounce copper sulphate to two quarts water), drain, roll in air-slaked lime, and plant at once.

SANITATION. Since the organisms (fungi and bacteria) which cause diseases of pepper may live over winter on diseased pepper plants and fruits, the complete destruction of all such diseased material is important.

Many pepper growers follow the practice of gathering the ripe pimiento fruits and piling them along the edge of the fields. They are there sorted and the diseased fruits, as well as those that are not marketable for other reasons, are left to decay at the edge of the field, remaining there as a source of infection during that season and for the following year.

Analyses have shown that cull pimientos and pimiento waste have considerable feeding value. Cattle, hogs, and chickens will eat considerable quantities of them. If cull peppers are fed to such stock in a pasture or lot they will be almost completely consumed. They should not be fed in a barn where unconsumed portions will get into the manure and be carried to the field again.

Seed bed sanitation is perhaps more important than sanitation in the field. Every possible precaution should be used to have only healthy plants set in the field, since spraying plants in the field is a very expensive operation.

If old seed beds are to be used the soil should be removed, the walls cleaned and given a coat of creosote. This should be done early in the winter so that the creosote will not injure the young seedlings.

The beds should then be filled with fresh clean soil sufficiently early to become firmly settled before the seed are planted.

Where clean woods soil is not available the old soil may be used again, if carefully disinfected. Where steam is available it furnishes the cheapest and most effective means of soil disinfection. If live steam is not available formaldehyde solution (sold commercially as formalin) is quite satisfactory. The soil should be spaded and pulverized before treatment. Add 1 gallon of formalin to 99 gallons of water and apply at least ½ gallon to each square foot of soil

with a sprinkling can. Then cover the bed with tarpaulins or two or three thicknesses of sacks to hold the fumes in the soil. After two to three days the covers may be removed. As soon as the soil is dry enough it should be spaded over to hasten escape of the formaldehyde. This treatment should be made at least two weeks before planting time.

The seed should be planted in rows four to six inches apart so as to allow cultivation and effective spraying of the seedlings.

If old cloths are used for covering the beds they should first be boiled or else soaked for one hour in a 5 per cent solution of copper sulphate.

SPRAYING. In spite of all precautions some disease may occasionally appear on the pepper plants. It is often necessary to spray for the control of plant lice. For these reasons it is advisable to spray the plants at least twice before setting to the field. Spraying a seed bed entails comparatively little cost and is always a worthwhile precaution.

The first spray should be applied soon after the first true leaves appear, using a 3-4-50 Bordeaux mixture. That is three pounds bluestone (copper sulphate), four pounds hydrated lime, and 50 gallons water. The second application should be made about two weeks later, using a 4-6-50 Bordeaux.

If plant lice are present nicotine sulphate (Black-Leaf 40) should be added to the Bordeaux mixture.

CROP ROTATION. Quality in pimientos as well as yield appears to be markedly influenced by environment, especially by soil type and weather conditions. A grower finding that a certain field produces a high yield of fruits of exceptionally high quality is inclined to plant that field in pepper continuously and, frequently, with disastrous results. With this practice diseases increase rapidly and soon the crop may be almost totally lost. Furthermore exhaustion of nutrient elements in the soil may seriously affect quality of the product after a few years.

For these reasons each grower should work out a rotation suited to his conditions, so that pepper will not be planted on the same field oftener than once in three years. One suggested rotation is: first year pepper; second year wheat or oats, followed by Iron or Brabham cowpeas; third year cotton with vetch or Austrian peas sown in the fall as a winter cover crop; fourth year pepper.

The cotton should be kept free of weeds throughout the summer and fall to prevent the development and increase of *Sclerotium rolfsii*, the fungus which causes Southern Blight.

Only Iron or Brabham cowpeas or other varieties known to be resistant to nematode root-knot should be planted at any time.